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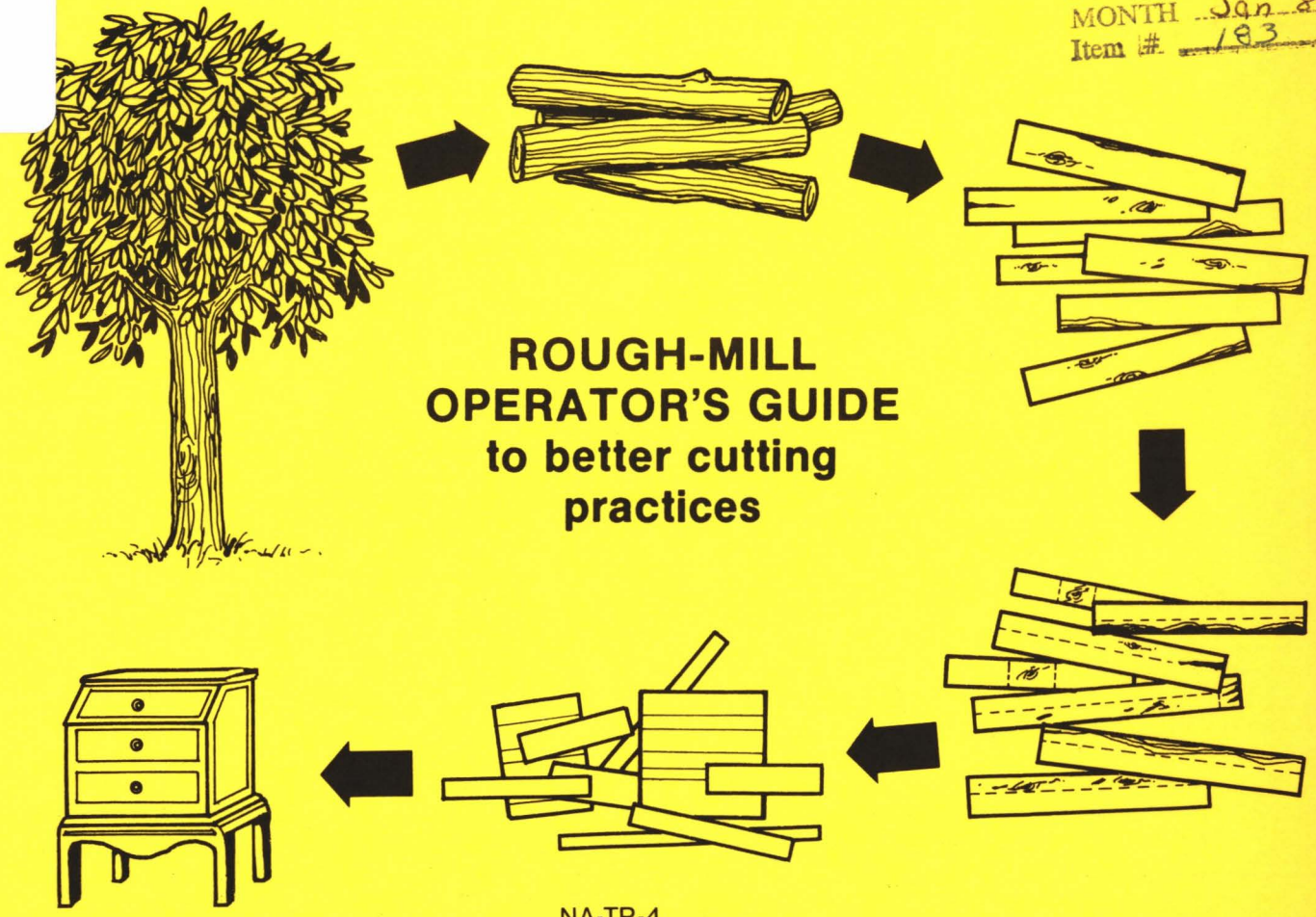

ROUGH-MILL OPERATOR'S GUIDE to better cutting practices

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NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
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Special thanks is offered to the many foremen and supervisors who have taken it upon themselves to daily monitor lumber waste and encourage their personnel to do their very best.

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This operator's guide informs rough-mill operators and foremen of methods to improve their efficiency of processing lumber. The scope of this guide is from the inexperienced off-bearer (soon to become an operator) to skilled rough-mill operators and foremen. The guide will help accomplish the following common objectives of lumber users and the USDA Forest Service:

1. Increase the efficiency with which lumber is utilized.
2. Improve lumber yields.
3. Reduce manufacturing costs.
4. Reduce lumber waste.
5. Extend our wood resource.

The company that seriously attempts to implement the practices contained in this guide will have the greatest gain toward yield improvement and accomplishment of the above objectives. Although substantial increase in efficiency may be made by a single operator, the company that initiates a progressive rough-mill yield improvement program will receive the greatest benefits.

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"We need more education in
the obvious than
research
into the obscure"

Oliver Wendel Holmes

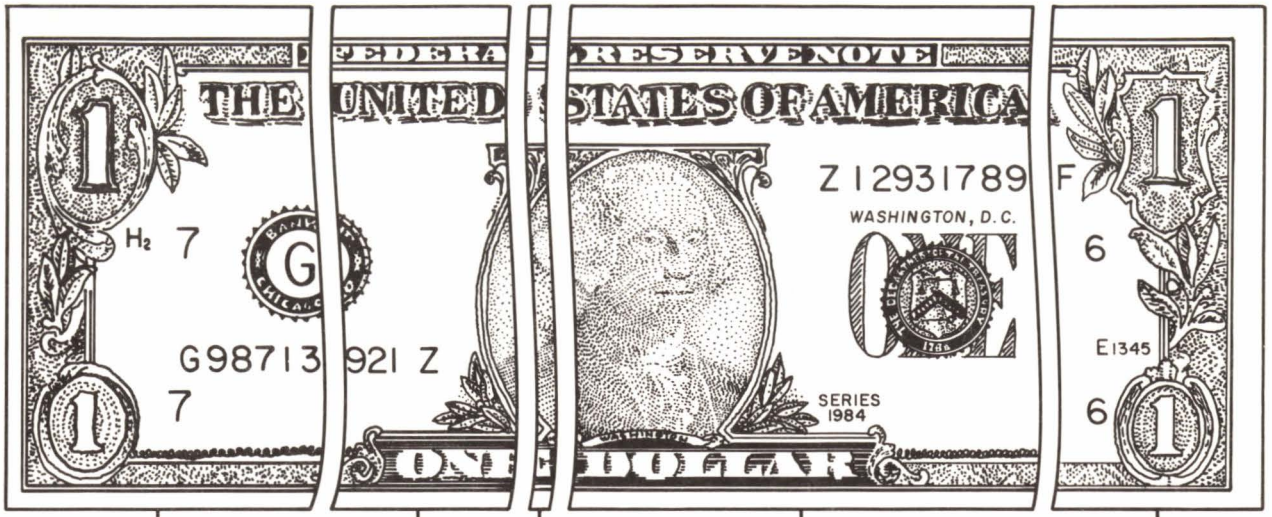
INTRODUCTION TO LUMBER PROCESSING EFFICIENCY

Lumber yield and rough-mill efficiency are many-sided concepts affected by variables such as lumber species, grade mix, lumber drying practices, lumber size, cutting order composition, operator experience, plant lay-out, machinery, processing sequence dictated by plant layout, and production scheduling. A slight change in variables may create a new profit or loss outlook for the rough-mill department — a concern for both management and rough-mill personnel. In fact, in no other department does a more concentrated potential for savings exist than in the rough mill. These cost reductions are bound to favorably affect the competitive pricing of a product in the market place.

Today the supply of upper quality lumber falls short of demand; lumber costs are higher than in years past. For the typical furniture factory, lumber is usually the greatest cost factor and easily exceeds 30 to 40 percent of all production costs (Fig. 1). In a dimension company, where parts are produced for furniture or cabinet manufacturing plants, the lumber cost can exceed 50 percent of total costs.

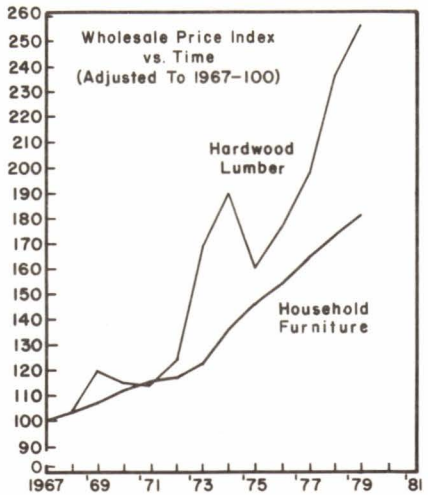
FIGURE 1.

WHERE DOES THE DOLLAR GO IN FURNITURE MANUFACTURING?



Manufacturing Costs

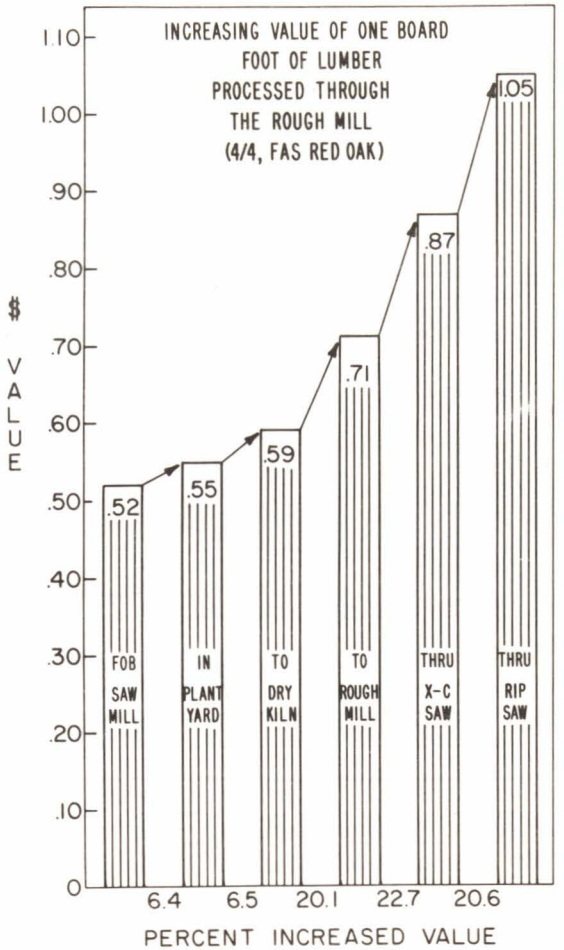
FIGURE 2.



The cost of lumber, often over twice the value of labor in the final sales dollar, is increasing much more rapidly than the price of furniture (Fig. 2).

As lumber is processed, value is added at each operation (Fig. 3). A rough mill processing 10,000 board feet of 6/4 red oak per day can easily save about $65,000 per year by improving lumber yield only 5 percent. With a little effort, the rough-mill personnel may increase yield 10 to 25 percent for additional savings.

FIGURE 3.



THE CUTOFF OPERATION

Description

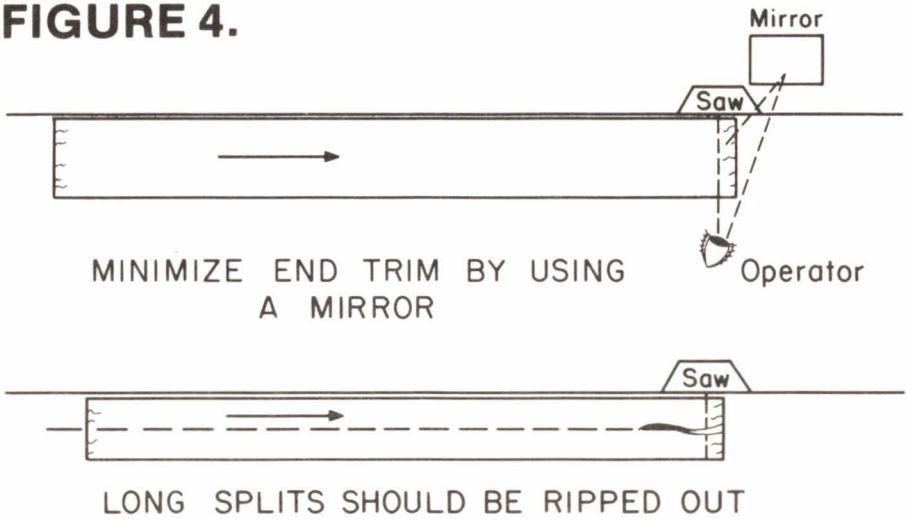
The cutoff or crosscut (X-C) saws cut boards across the grain; that is, across the board, into lengths required by the cutting bill. Cutting bills are lists of part quantities and sizes needed to produce final products such as furniture or cabinets. The cutoff operation is NOT an island, but must coordinate with the other operations (ripping, planing, salvage, moulding, and tenon operations).

If the cutoff-saw operation is performed first, for best yields the cutoff-saw operator should not try to remove all defects since some defects can be ripped out later with less waste. Stock leaving the ripsaw will be free of most defects objectionable in the finished product, but this is not true of the cutoff saw.

Defecting lumber

Your first cut to square the end should remove end checks if present. Keep end trim small, and use a mirror to inspect your cut to see if an additional cut must be made (Fig. 4). Develop the skill to remove only that portion of lumber containing the defect. Your increased yield can amount to hundreds of dollars in savings.

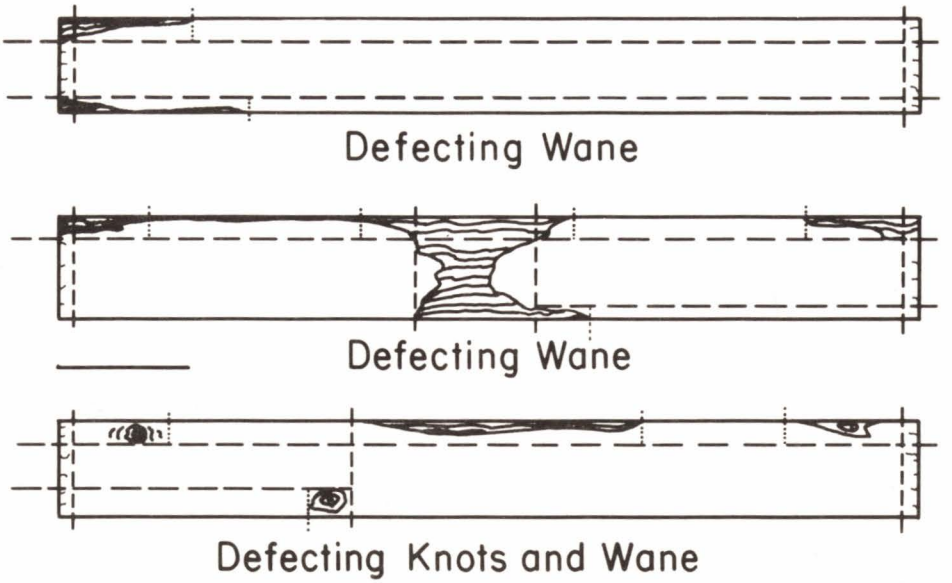
FIGURE 4.



When round logs are sawed into rectangular boards, wane (bark or lack of wood) allowed in the grading rules is left on the board for the rough mill to remove. If the crosscut-saw operation is performed first, coordination with ripsaws allows wane, pith, and some knots to be removed by ripping or at the salvage operation. At first these lumber savings may appear insignificant, but the best operators know that the decisions they make add up to real savings. Skilled crosscut-saw operators are in high demand because their job requires quick, accurate decisions that affect the rest of your company's production.

After end trimming, cut a length from your current cutting bill. Figure 5 illustrates crosscuts (¦), rips (---), and subsequent salvage cuts (⋮). If your plant rips first, the cuts will be similar.

FIGURE 5.

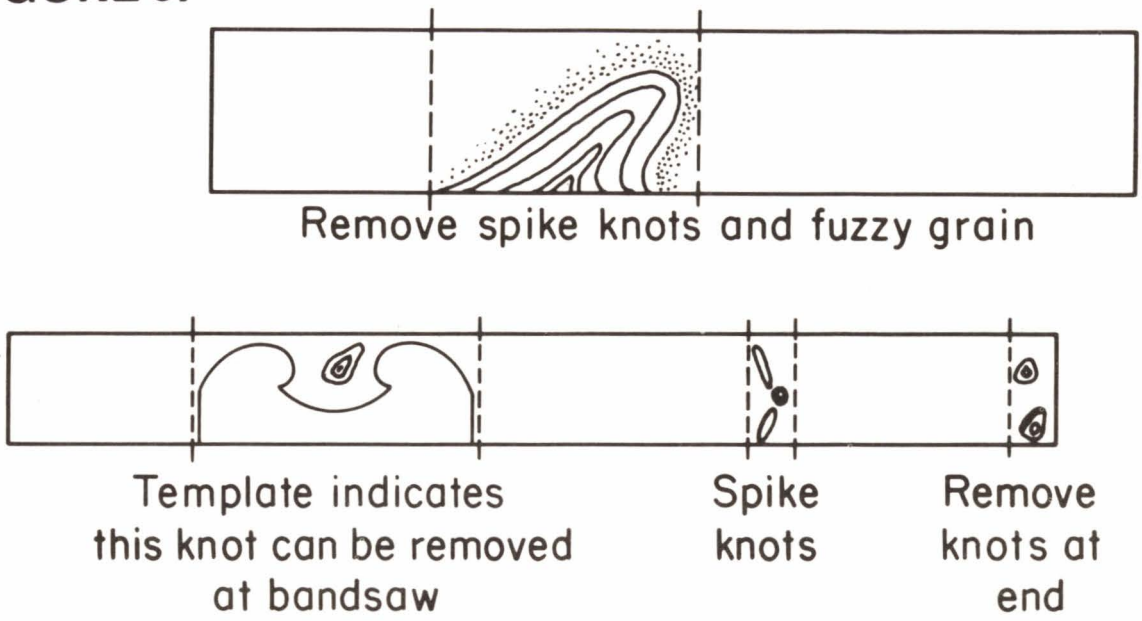


Some defects, especially those extending over 50 percent of the board width, should be removed by the cutoff-saw operator. Spike knots and multiple knot clusters with their distorted "fuzzy grain" should be removed. Fuzzy grain may lead to torn grain in later machining.

Sometimes it is advantageous to remove small defects, for example, when they are near the board's end. You must decide the importance of sacrificing some yield to meet your cutting bill requirements. Know what type and size of defects are acceptable in the final product — leave these remain to increase yield.

When some intricate parts are difficult to obtain, a template of the finished part's rough size will increase rough-mill yield (Fig. 6).

FIGURE 6.

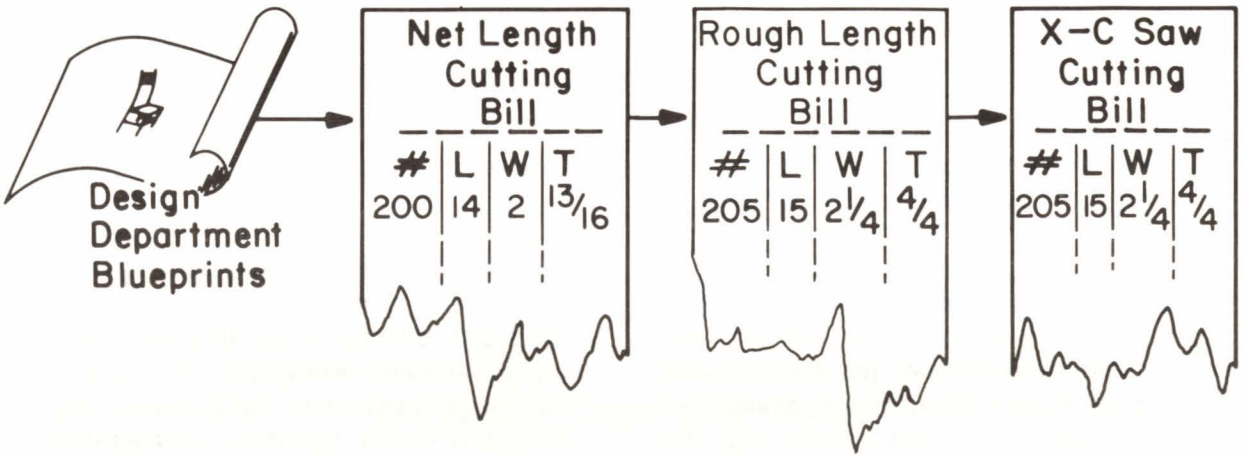

Remove spike knots and fuzzy grain
Template indicates this knot can be removed at bandsaw
Spike knots
Remove knots at end

Scheduling

Factors that affect the scheduling of cuttings include the length of parts, width of parts, historical difficulty obtaining parts, priority of parts, quantity of parts, etc. Experienced cutoff-saw operators and foremen schedule their cutting orders for the saw to achieve the required number of cuttings with the least amount of lumber. Scheduling, a key factor in securing yields, begins before the first set-up. Over 5 percent increase in yield can be achieved by proper scheduling, regardless of the lumber grade.

When the X-C saw is cutting random width, rough lumber, the cutting bill for the X-C saw will be converted into a volume of random-width pieces (Fig. 7). Often the X-C saw's production is expressed in layers, courses, or tiers to be stacked on a pallet, hand truck, or cart.

FIGURE 7.—THE CUTTING BILL.


Design Department Blueprints
Net Length Cutting Bill
L W T
200 14 2 13/16
Rough Length Cutting Bill
L W T
205 15 2 1/4 4/4
X-C Saw Cutting Bill
L W T
205 15 2 1/4 4/4

SCHEDULING THE CUTOFF SAW'S CUTTING ORDER

I. Decide what lengths you should cut first.

A. Always place the most difficult size to find in the initial set-up.

1. Longest length.
2. Widest width.

B. Include other lengths that represent the most footage in the cutting bill requirements because they take longer to accumulate.

C. Remember that some shorter lengths will be generated during the salvage operation.

D. Choose nonmultiple lengths (not 12, 24, 36, or 48 inches).

E. Use lengths that will minimize distance between stops.

F. When long lengths over 50 inches are required, a good operator includes several medium and short lengths to reduce loss at tail end of board.

G. Combinations of your lengths should fill gaps in the backgauge.

II. Decide how many lengths you should cut.

A. Experience indicates that five to nine well distributed lengths in the cutting order leads to best yields.

1. More lengths are fine, but may cause problems:

a. Difficult to sort lengths that are too close together.

b. Difficult to make calculations and decisions.

2. More lengths → less gaps → higher yield.

B. When the cutting bill contains no long lengths, you may reduce the number of lengths to cut together.

C. Substitute similar lengths after you have fulfilled cutting bill requirements.

1. Include the next most difficult length(s) first.

2. Only the shortest lengths will remain at the end of the bill's production to be obtained through coordination at the X-C and salvage saw.

3. Seek other jobs' cutting bills when you run out of lengths to cut.

III. Decide which lumber you should use for your cutting bill.

A. Use the lowest, least cost grade(s) if your cuttings can be obtained.

B. Usually, yield drops with lower grades *but* you make the most efficient use of wood.

C. If your lumber packages vary in length (8 feet, 10 feet, etc.), choose rough lumber which best fits your cutting bill lengths.

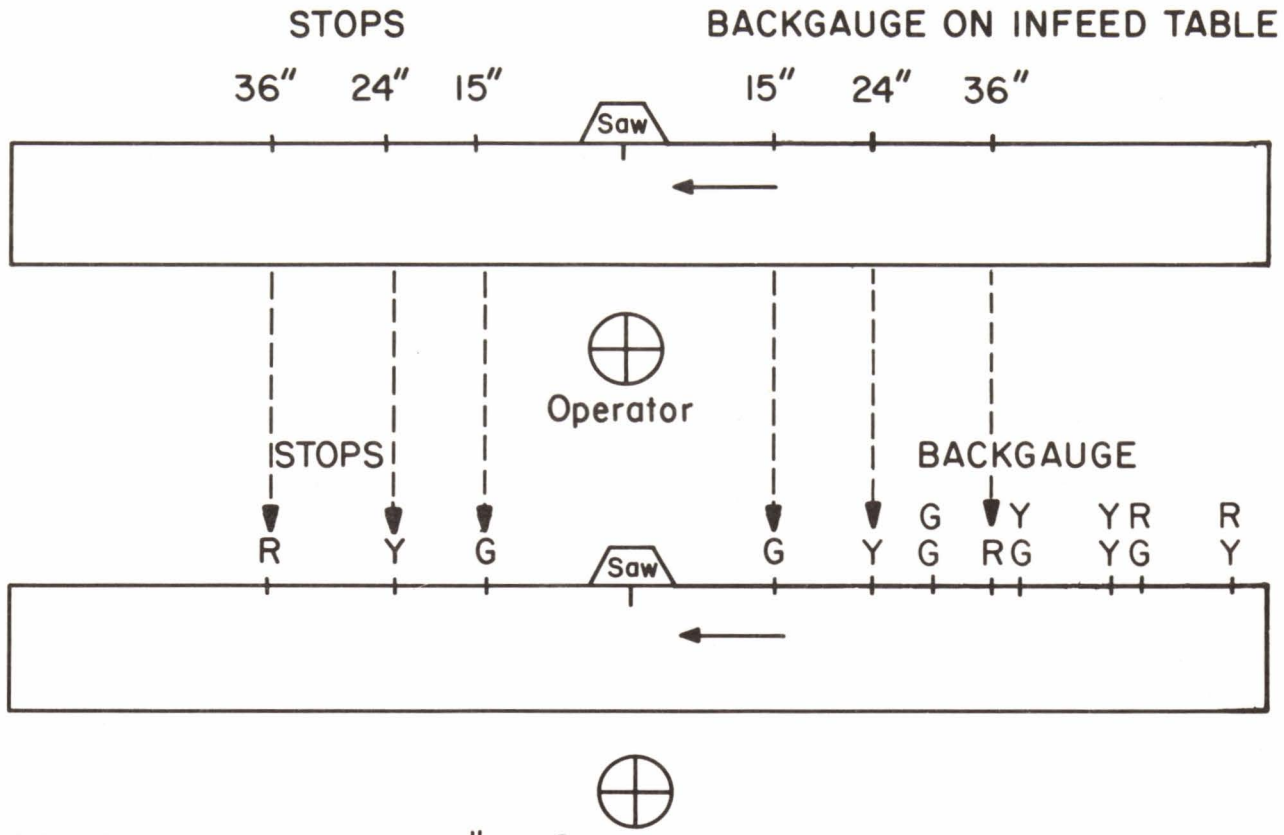
D. Computers, publications, and industry consultants can help you decide.

Use the backgauge to save lumber

The backgauge is a simple device that can be located above the infeed table of any crosscut saw. Each cutting length set on the "stops" is also marked on your backgauge. The backgauge is a tool that is useful in reducing end trim loss at the board's trailing end. Equally important is its function in allowing an operator to strategically plan cuts around defects. Yield improvements of over 4 percent have been documented by cutoff operators who use backgauges.

Color code each length on the backgauge to match the same colored stop. Another common practice is to pair different lengths with each other to help fill the backgauge. The operator has many alternative choices for cutting — waste is minimal (Fig. 8).

BACKGAUGE COLOR CODING AND SET-UP



GG = GREEN + GREEN = 30"
GY = GREEN + YELLOW = 39"
YY = YELLOW + YELLOW = 48"
RG = RED + GREEN = 51"
RY = RED + YELLOW = 60"

G = Green = 15"
Y = Yellow = 24"
R = Red = 36"

FIGURE 8.

HOW TO USE A BACKGAUGE

When the board is placed on the infeed table, the operator views both sides of the board and places the poorest face up. Remembering the defects on the underside of the board, the operator visually scans the face for defects and decides which lengths to cut while using the backgauge as a guide.

In Figure 9 an 11 foot, No. 1 common board is placed on the infeed table with poorest face up and is ready to be cut. The operator checks for defects *to be removed at the cutoff saw* and decides to first cut a clear 36-inch piece (red). The next choice to cut another 36-inch piece (red) assumes that the defect will be removed by ripping. Note the future ripping of the length containing the defect will make one 24-inch (yellow) or two 15-inch (green) pieces in the salvage operation.

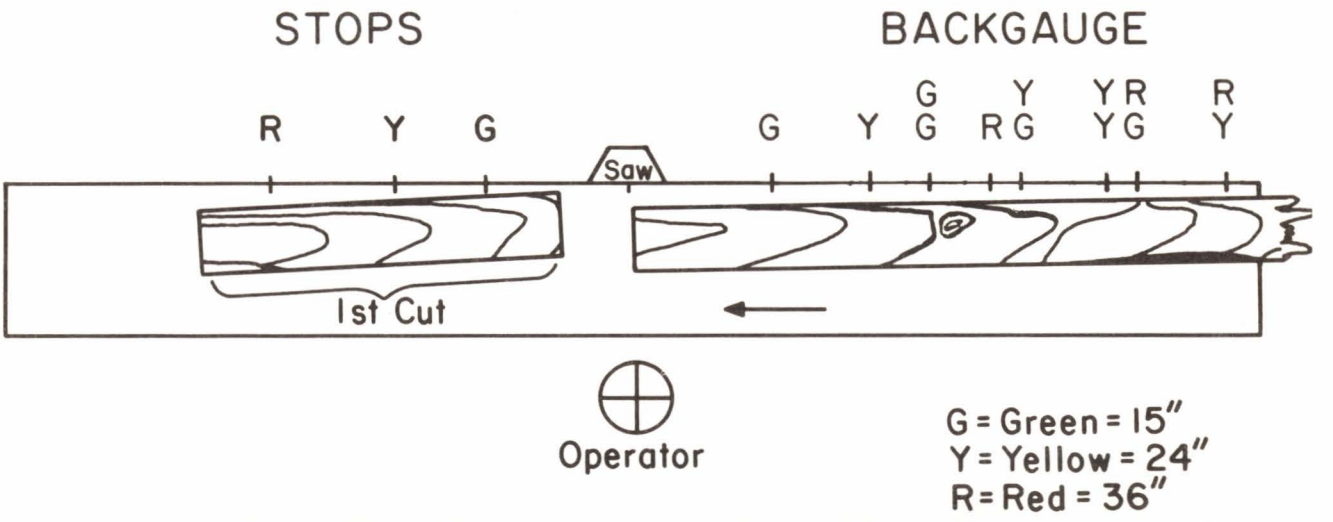


FIGURE 9.—HOW TO USE A BACKGAUGE.

The operator has removed 6 feet from the original 11-foot board. Guided by the backgauge, the operator sees that the end of the board falls just beyond the red + yellow mark. He knows that a red (36 inch) and a yellow (24 inch) can be cut with small end trim waste. Use of this easy system eliminates mental gymnastics and lumber can be defected strategically and end trim can be minimized.

As you add more lengths, color code each length. Be careful in combining lengths to avoid cluttering the backgauge and complicating its use. In Figure 10 some low priority 15-inch shorts were excluded even though they would have more completely filled in the backgauge. Pair the most needed lengths with each other first to make them appear more frequently on the backgauge. Small preprogramed computers are available for printing out paper backgauges to be fastened to the infeed table for each new cutting order.

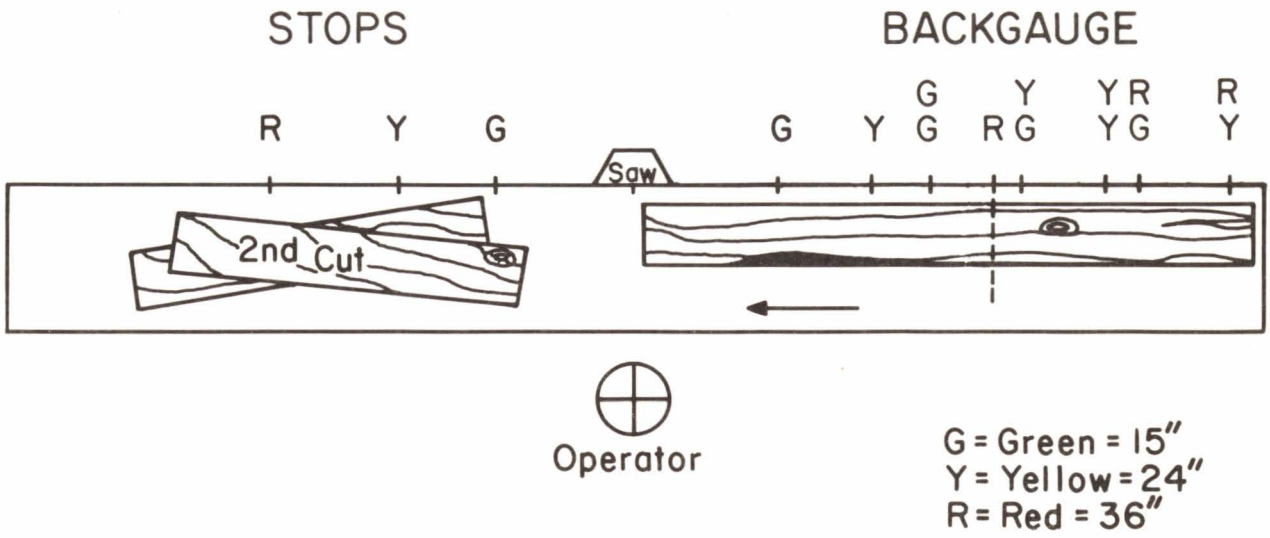


FIGURE 10.—FURTHER USE OF A BACKGAUGE.

Cutoff saw checklist

- Coordinate with all following operations.
- Keep end trim small by using a mirror.
- Square end by keeping board against fence.
- Remove large defects like spike knots and decay.
- Know what defects are acceptable in the final product — such as sound pin knots, bird peck, distorted grain, one clear face, etc.
- Have your supervisor explain thoroughly the defects and cosmetic blemishes that are allowed.
- Remember defects on both board faces.
- Some end checks and splits would best be left for the ripsaws.
- Run crosscut blade in defect to leave maximum clear wood.
- Cut most difficult sizes first.
- Saw short lengths as a last resort to minimize end trim on the board's tail end with help from your backgauge.
- Cut medium and short lengths from crooked and twisted lumber.
- Cut five to nine different lengths to minimize distance between stops.
- When choosing lengths, remember to fill gaps in the backgauge.
- Cut lengths assigned and no more — extra allowances reduce yield every cut.
- Combine various jobs' cutting bills to obtain higher yields if necessary.
- Check and tighten stops to prevent drifting and slippage.
- Use the lowest, least cost grade(s) of lumber from which your cuttings may be obtained.
- Choose the lumber package length most suited for your cuttings.

- Use the backgauge to defect lumber most efficiently.

- Color-coded backgauges display cuttings in high demand because they are combined frequently with other colors.

- When cutting consider the width requirements of final dimension, specified (solid) width versus random (glued-up) width.

- Make the work environment productive: use adequate lighting, keep area clean, use a pivot pin to aid in unloading a low pile, and keep machinery repaired and blades sharp.

- Turn cupped boards concave side ( ) down before surfacing.

THE RIPSAW OPERATION

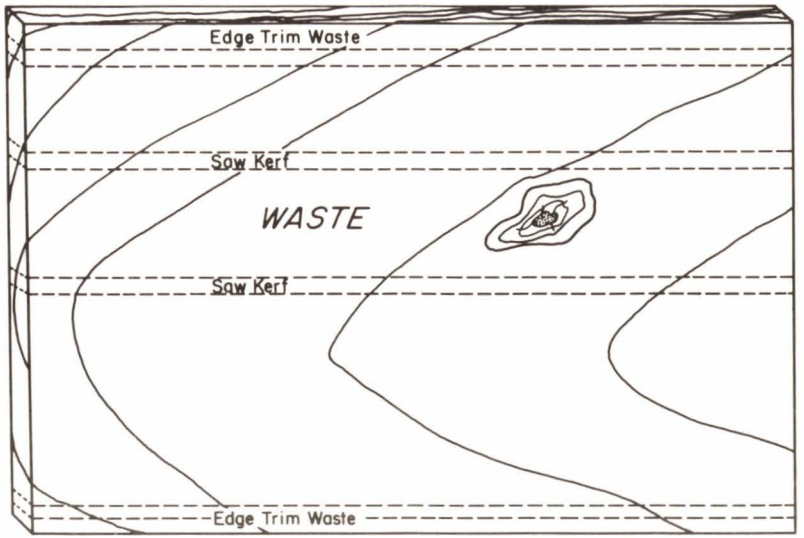
Description

Ripsaws saw boards parallel to the grain which usually runs along the board length. More lumber is wasted because of excessive kerf and edging losses than for any other reason; therefore, the number of cuts at a ripsaw should be kept to a minimum. Edging strips removed in truing the initial edge should not exceed 1/32 inch; the best ripsawyers' initial edging is just sawdust. Set your fence stop to remove the saw kerf initially and always use your fence. Rip cuts should be buried in defects to minimize waste of usable wood.

Figure 11 shows that 41 percent of the lumber is lost in a wasteful ripping process.

FIGURE 11.

WASTEFUL RIPPING



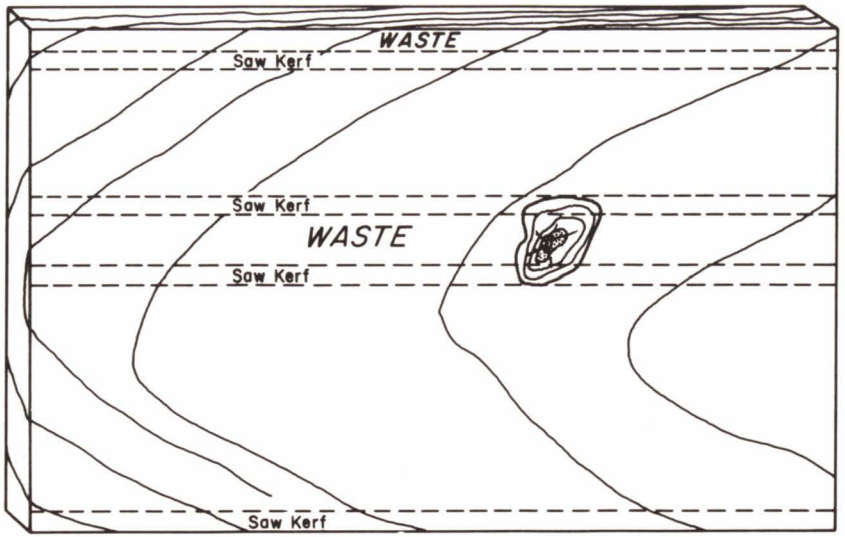
Accurate ripping

Small improvements in yield can lead to considerable savings (Fig. 12). Here the operator has minimal edgings required to obtain a clean, gluable edge. The saw blade was buried in the defect to avoid "picture framing" the knot by wasting usable wood around the defect. A guideline (shadow or laser light line) mounted above the table can indicate precisely where the board will be ripped. When the guideline is used with your fence, the extra wood saved near the defects and edges increases yield.

In the properly ripped board (Fig. 12), 30 percent of the board is wasted in saw kerf and defecting, but that is an increase of 11 percent in yield over the wasteful ripping process.

FIGURE 12.

ACCURATE RIPPING



Tailing the ripsaw and panel matching

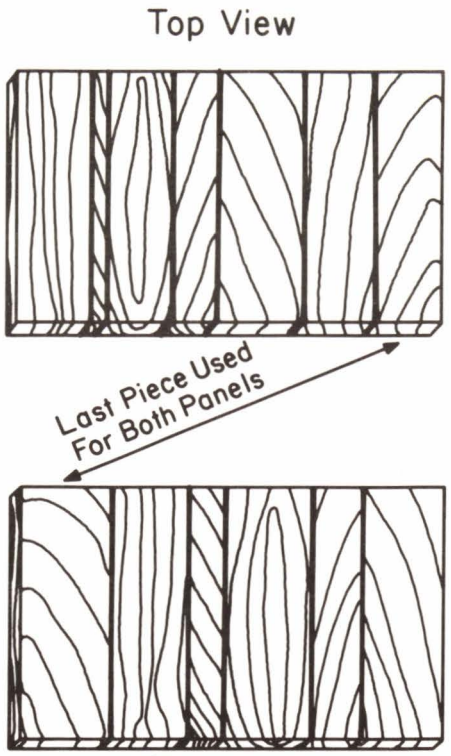
The trailer or off-bearer working opposite from the ripsaw operator has an important job. It is the off-bearer's responsibility to inspect each piece to determine whether it meets specifications, should be reripped, or should be sent to salvage saws for cut back. Return "rerip" pieces to the sawyer with the good edge in the same direction; all defects should be face up.

When the tailer is responsible for laying up panels, use material free from objectionable defects. Any waste at this stage of manufacturing is costly. The procedures for panel lay-up are shown in Figure 13. The overage of the first panel is used as the first piece of the next panel. If you do not have an automatic panel lay-up table to set the rip fence for the last piece, send the entire panel through the saw to obtain the required panel width. The last piece for the panel should be wide enough to enable the panel to be trimmed to width and also allow an extra piece of the required size to start the next panel.

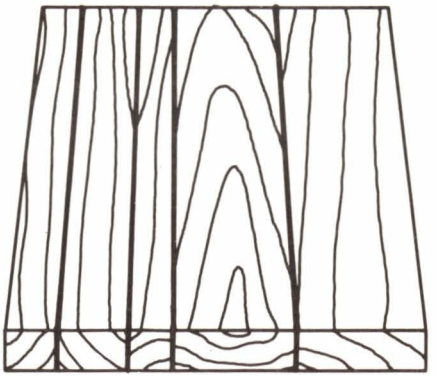
Alternate the annual rings in your panels to help stabilize the panels (Fig. 13). If all the annual rings faced the same direction, the panel could cup.

Usually the tailer must also count panels or pieces to determine when piece requirements are completed and to prevent overruns.

PANEL MATCHING



Using Overage From Preceding Panel For First Piece in Next Panel



Matching Wood Grain to Stabilize Panel

FIGURE 13.

Ripsaw checklist

- Know end-use requirement (clear 1 side, clear 2 sides, sound, etc.).
- Leave maximum size and number of allowable defects and rough edges.
- Coordinate with all other operations.
- Some reasonably clean, straight edges scheduled to go through the moulder should not be edged.
- Know minimum and maximum piece widths for panels.
- Use a wide board as the last piece on a panel to allow for extra width to start the next panel.
- Glued panel stock may not have to be perfectly parallel.
- Minimize edge trim to less than 1/32 inch.
- Place saw kerf inside defect to keep the most usable wood.
- Use thin kerf blades and large, ground collars.
- Keep blades sharp and free of pitch or gum.
- Check fence stops to prevent drift and slippage.
- Use a spring or pedal-activated pop-up table fence to make accurate initial edgings.
- Make test rips to determine fastest feed speed.
- Gang rip where possible.
- Upper feed rollers must be clean and properly adjusted.
- Check upper feed rolls every time thickness is changed to insure proper pressure and accurate ripping.
- Rip more than one specific width and random width from the same length if possible.
- If long lengths tend to crook (see appendix diagram), perform equal machining on each

edge. Check dry kiln procedure to determine whether sufficient stress relief is performed.

- Obtain specified widths (solids) from the edge of the board.
- Use remaining random widths from the center of the board for glued panels.
- The off-bearer's responsibilities include inspection, panel layup, and counting.
- Work station must be clean and well lighted.

SALVAGE OPERATION

In a salvage operation pieces containing defects from earlier machining are cut back to remove the objectionable defect. An effective salvage operation can improve yield up to 25 percent. Only when salvage or cutback is coordinated with the crosscut and ripsaw operations can its fullest potential savings be realized. The salvage saw must generate *usable* sizes; piles of shorts in stock with no buyer are wasted money.

Salvage should be *one* final operation — either ripping or cutoff. The offal must be cut to sizes in the cutting bill relatively fast to insure profitable operation.

PLANT LAYOUT

You are probably limited with your present plant layout of either a crosscut-first or a rip-first operation, but the question of whether to rip or to crosscut first is often asked. Since your company produces various sized parts, the plant should accommodate those sizes. While most plants crosscut first and some plants rip first, the most flexible companies have two lines or one flexible line.

The decision to X-C or rip first will be determined by your product. Kitchen cabinet, flooring, moulding, and millwork companies usually rip first (often by gang ripsaw) because their products are long and narrow. Furniture companies making casegoods, etc. and some dimension companies crosscut first to obtain clear, wide widths. Companies with flexible options obtain highest yields by either crosscutting or ripping first, depending on their product line and nature of the lumber.

OTHER METHODS OF IMPROVING YIELD

- Establish plant humidity control.
- Bury defects in the final product or produce "character marked" products with sound, natural defects.
- Finger joint or use SEM joints (for information, write SEM, Box 152, Princeton, WV 24740).
- Coordinate all operations to reasonable engineering specifications with minimal overages and allowances.
- Evaluate advantages in changes of production sequences like rip or cutoff first and surfacing before crosscutting and ripping.
- Remove some defects at moulder, mill room, lathe, finishing, etc.
- Stamp rejects to be used in future setups.
- When processing expensive species and/or grades (walnut, cherry, rosewood, FAS, etc.), use inexpensive woods (pine, poplar, etc.) for setup samples. This minimizes costly rejects at the bandsaw, sticker (moulder), tenoner, etc.
- Review lumber purchasing procedures and expected yields and costs with USDA Forest Products Laboratory (Box 5130, Madison, WI 53705) yield reports and/or computerized yield programs.
- Match length and grade of incoming lumber to the cutting bill requirements.
- Continually monitor yields and costs to indicate trends.
- Examine records to set priorities on cost reduction of expensive items.
- Review procedures in the following areas: lumber yard and handling, operator cutting methods, parts scheduling, rough-mill layout, make parts or buy dimension, lumber drying defects, engineering specifications, route sheets, and equipment evaluation.
- Take advantage of RIP (Rough-mill Improvement Program), a service for lumber users providing assistance in all of the topics mentioned in this booklet. Contact the forest products utilization specialist distributing this booklet or the RIP Base Center, USDA Forest Service, State and Private Forestry, 1992 Folwell Avenue, St. Paul, MN, 55108.

APPENDIX

Dimension parts grading system example

Knowing the end-use requirement or grade of each dimension piece is essential. Depending on their location, certain defects and cosmetic blemishes are permissible in the final product. This grading system developed by a grandfathter clock manufacturer saves $75 every thousand board feet processed.

GRADE A

Must be of required wood species. Must be straight, free of knots, checks, and mill defects.

GRADE B

Must be of required wood species. Some small knots and checks acceptable if eliminated by subsequent machine operations.

GRADE C

Must be of required wood species. May have some small knots, checks, or mill defects but must be structurally sound. May be produced from shorts, edgings, or other offal.

GRADE CX

May be of any wood species except pine. May have some knots, small checks, or milling defects not removed by subsequent operations but must be structurally sound. Should be produced from shorts, edgings, or offal.

To insure that operators understand the standards, companies erect displays with examples of each grade.

Rough mill mathematics

One board foot = 144 cubic inches

Example: 12″x12″x1″ or 24″x6″x1″ or equivalent

$$\text{Board footage (BF)} = \frac{\text{Length (inches) x Width (inches) x Thickness (inches)}}{144}$$

$$\text{Surface measure (Square feet)} = \frac{\text{Length (feet) x Width (inches)}}{12}$$

$$\text{Yield (\%)} = \frac{\text{Total board footage output}}{\text{Total board footage input}} \times 100$$

$$\text{Net cost of lumber (\$ per MBF)} = \frac{\text{Cost of dry lumber in \$/MBF}}{\text{Yield in percent}} \times 100$$

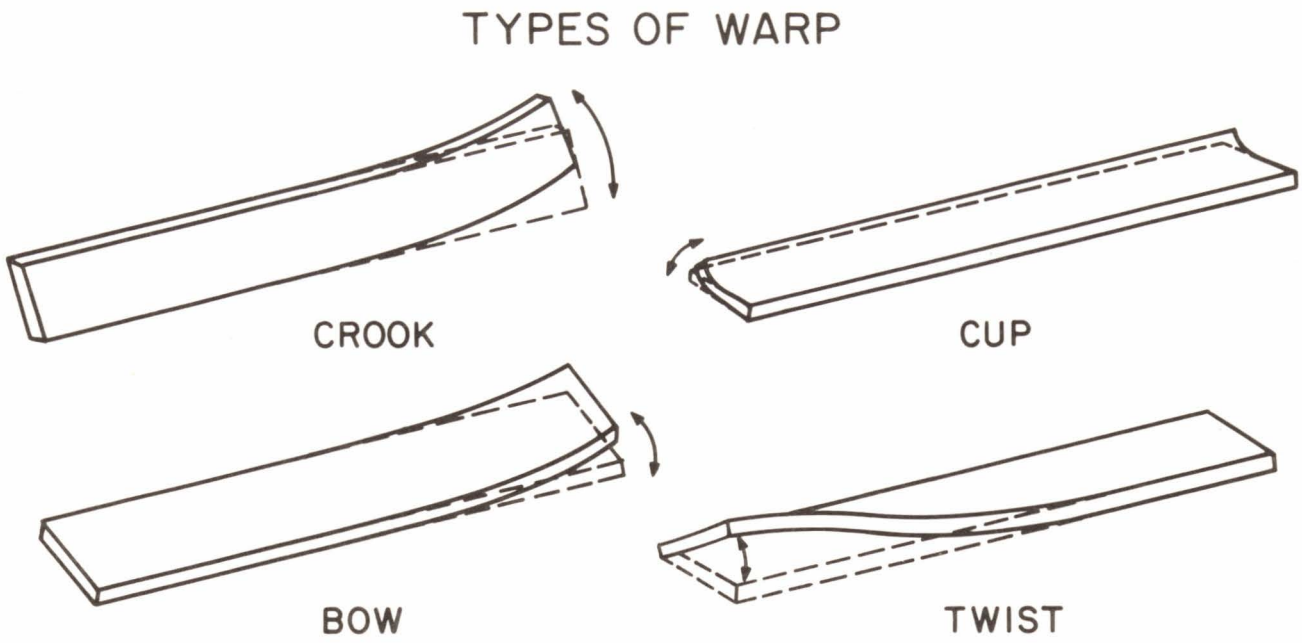
MBF = One thousand board feet

Lumber thicknesses are nominal—usually some extra thickness is included.

4/4 = 1″	8/4 = 2″
5/4 = 1-1/4″	10/4 = 2-1/2″
6/4 = 1-1/2″	12/4 = 3″

Which of these are defects in your company? What are the size limitations?

Rot	Knots	Insect holes
Shake	Sound	Distorted grain
Wane	Loose	Bird's-eye
Splits	Small	Surface checks
Pith	Clusters	End check
Warp	Stain	Bark pockets



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